AD-A067 631 ILLINOIS UNIV AT CHICAGO CIRCLE DEPT OF MATHEMATICS F/G 12/1
PATTERN RECOGNITION FOR CERTAIN STOCHASTIC DATA STRUCTURES.(U)
MAR 79 S L SCLOVE AFOSR-77-3454

UNCLASSIFIED AFOSR-TR-79-0321 NL

| OF |
AD
A067631

END
DATE
FILMED
6-79
DDC

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: AFOSR-TR- 79-0321
2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
PATTERN RECOGNITION FOR CERTAIN STOCHASTIC DATA STRUCTURES

5. TYPE OF REPORT & PERIOD COVERED
Final

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
Stanley L. Sclove

8. CONTRACT OR GRANT NUMBER(s)
AFOSR 77-3454

9. PERFORMING ORGANIZATION NAME AND ADDRESS
University of Illinois at Chicago Circle
Department of Mathematics, Box 4348
Chicago, Illinois 60680

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
61102F 2304/A5

11. CONTROLLING OFFICE NAME AND ADDRESS
Air Force Office of Scientific Research/NM

12. REPORT DATE
March 1979

13. NUMBER OF PAGES
5

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report)
UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Pattern recognition; multivariate statistical analysis; infinite divisibility

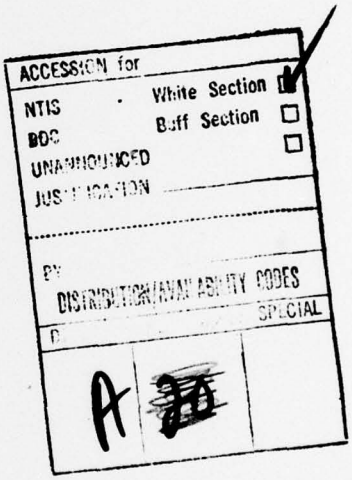
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
During the grant support period one investigator was partially supported and conducted research. Two areas of research were investigated. The first area deals with generalization of correlation analysis to the class of infinitely divisible distributions. This class includes but is not limited to the family of normal distributions. Testing the hypothesis of independence of infinitely divisible variables was developed and applied to time series and stochastic processes. A method for testing the hypothesis of multivariate normality against infinitely divisible alternatives was investigated. The second area that was studied dealt

DD FORM 1 JAN 73 1473

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. Abstract continued.

with the two-dimensional Markov models in pattern recognition. The principal investigator shows how to use the spatial correlation to classify images, bringing in the spatial correlation through a two-dimensional autoregressive model.



(18) AFOSR-TR- (19) 79-0321

(11) 7 Mar 79

(12) 7 p.

FINAL SCIENTIFIC REPORT

(15) Grant AFOSR-77-3454

(6) PATTERN RECOGNITION FOR CERTAIN STOCHASTIC DATA STRUCTURES.

Submitted to: Air Force Office of Scientific Research
Bldg. 410
Bolling Air Force Base, DC 20332

Att'n: Dr. I.N. Shimi

Principal Investigator: Stanley L. Sclove

Stanley L. Sclove, Associate Professor
Department of Mathematics
University of Illinois at Chicago Circle
Box 4348, Chicago IL 60680

March 7, 1979

(9) Final rept. 30 Sep 77-30 Sep 78.

(10) Stanley L. / Sclove

(16) 2304 (17) A5

401 950

FINAL SCIENTIFIC REPORT

Grant AFOSR 77-3454:

Pattern Recognition for Certain Stochastic Data Structures

9/30/77 - 9/30/78

Outline

1. Review of Accomplishments
   1.1. Generalization of Correlation Analysis
   1.2. Two-Dimensional Markov Models in Pattern Recognition
2. List of Technical Reports, with Indication of Publication Status

This report is a summary of work performed under Grant AFOSR 77-3454, "Pattern Recognition for Certain Stochastic Data Structures." The report has two sections: a review of accomplishments and a list of tecnical reports, with an indication of their publication status.

1. Review of Accomplishments

1.1. Generalization of Correlation Analysis

The problem of measuring dependencies among several variables is in general a difficult one. The problem is greatly simplified in cases in which it suffices to measure the dependencies pairwise. The correlation coefficient is sufficient to measure the dependence between jointly normally distributed variables. The assumption that variables are normally distributed is restrictive. It is desirable to work within a less restrictive framework. Such a framework is provided by the class of infinitely divisible distributions. This class includes but is not limited to the family of normal distributions. In fact, it is a broad class, including many families of distributions. Pierre (1971) showed that a measure of dependence in this larger family is the correlation between the squares of the variables (after centering at their expectation). Sclove (1976b) had shown how to test the hypothesis of independence of infinitely divisible variables. This work was revised for publication under Grant AFOSR 77-3454 and appeared in the September, 1978 issue of the *Journal of Multivariate Analysis*. In the revision it was indicated how to apply the results to time series and stochastic processes. This extension to time series and stochastic processes was expanded into a paper and submitted to the journal *Annals of Probability* [Sclove(1978e)]; it was not accepted and will be revised and submitted again or to another journal (possibly *Stochastic Processes & Applications*).

The work of Pierre (1971) and Sclove (1976a,b) raises the question of when one needs to use the more general infinitely divisible model for continuous multivariate data, rather than working within the narrower framework of the multivariate normal family. This question was tackled in Sclove(1978c), a paper which gives a method for testing the hypothesis of multivariate normality against infinitely divisible alternatives; this paper has been submitted to the *Journal of Multivariate Analysis*.

1.2. Two-Dimension Markov Models in Pattern Recognition

Some pattern recognition problems in two dimensions (the plane) were studied under Grant AFOSR 77-3454.

Earlier work of Osterburg, Parthasarathy, Raghavanand Sclove (1977) on the occurrence of fingerprint characteristics was treated as a two-dimensional Markov process. The paper, Sclove(1978a), has been accepted for publication in the *Journal of the American Statistical Association*. The paper Sclove(1978b) is being considered for publication in *Communications in Statistics (A)*.

Within the same framework, pattern recognition problems in two dimensions, some image-processing problems were treated in Sclove (1978d). Landgrebe (1978) had remarked that in spectral data remotely sensed by satellite, different types of terrain (deciduous forest, forage, concrete, etc.) yielded not only different means and variances of intensities, but also different amounts of spatial correlation. Yet this fact has not been exploited in the processing of such data. Sclove (1978d) shows how to use the spatical correlation to classify images, bringing in the spatial correlation through a two-dimensional autoregressive model (Markov random field). This paper has been refereed and is being revised for re-submission (to *IEEE Transactions on Pattern Analysis and Machine Intelligence*) according to the referees' suggestions.

REFERENCES

Landgrebe, D.A.(1978). "The Development of a Spectral/Spatial Classifier for Earth Observational Data." *Proceedings IEEE Computer Society Conference on Pattern Recognition and Image Processing*, 470-475.

Osterburg, J.W., Parthasarathy, T., Raghavan, T.E.S. & Sclove,S.L.(1977). "Development of a Mathematical Formula for the Estimation of Fingerprint Probabilities based on Individual Characteristics." *Journal of the American Statistical Association 72* 772-778.

Pierre, P.A.(1971). "Infinitely Divisible Distributions, Conditions for Independence, and Central Limit Theorems." *Journal of Mathematical Analysis and Applications 33* 341-354.

Sclove, S.L.(1976a). "Infinitely Divisible Distributions in Statistical Inference: Heavy-tailed Distributions and Convolution Models." Technical Report, AFOSR Grant 76-3050, Dept. of Mathematics, University of Illinois at Chicago Circle, Nov., 1976.

Sclove, S.L.(1976b). "Testing Independence of Variates in Infinitely Divisible Random Vectors." Technical Report, AFOSR Grant 76-3050, Dept. of Mathematics, University of Illinois at Chicago Circle. Revised under AFOSR Grant 77-3454. Appeared in *Journal of Multivariate Analysis*, Vol. 8, No. 3, Sept. 1978, pp. 479-485.

Sclove, S.L.(1978a). "The Occurrence of Fingerprint Characteristics as a Two-Dimensional Process." Technical Report, AFOSR Grant 77-3454, Dept. of Mathematics, University of Illinois at Chicago Circle, Feb. 15, 1978. (To be scheduled for publication in the Sept., 1979 issue of *Journal of the American Statistical Association.*)

Sclove, S.L.(1978b). "The Occurrence of Fingerprint Characteristics as a Two-Dimensional Poisson Process." Technical Report, AFOSR Grant 77-3454, Dept. of Mathematics, University of Illinois at Chicago Circle, May 15, 1978. (Submitted to *Communications in Statistics(A)*. Revised Feb., 1979.)

Sclove, S.L.(1978c). "Testing the Hypothesis of Multivariate Normality against Infinitely Divisible Alternatives," Technical Report, AFOSR Grant 77-3454, Dept. of Mathematics, University of Illinois at Chicago Circle, Aug. 15, 1978. (Submitted to *Journal of Multivariate Analysis.*)

Sclove, S.L.(1978d). "Pattern Recognition in Image Processing using Inter-Pixel Correlation." Technical Report, AFOSR Grant 77-3454, Dept. of Mathematics, University of Illinois at Chicago Circle, Aug. 16, 1978. (Submitted to *IEEE Transactions on Pattern Analysis and Machine Intelligence.*)

Sclove, S.L. (1978e). "On the Spectral Analysis of Infinitely Divisible Stochastic Processes," Technical Report, AFOSR Grant 77-3454, Dept. of Mathematics, University of Illinois at Chicago Circle, Sept. 30,1978.

2. List of Technical Reports, with Indication of Publication Status

"Testing Independence of Variates in an Infinitely Divisible Random Vector"
(Began as Technical Report, AFOSR Grant 76-3050, Nov., 1976.)
(7/23/77 1st revision submitted)
11/29/77 2nd revision submitted
Paper appeared in *J. Multivariate Analysis*, Sept., 1978 (Vol. 8, No. 3), pp.479-485.

"The Occurrence of Fingerprint Characteristics as a Two-Dimensional Process,"
Technical Report. AFOSR Grant 77-3454, Math. Dept. UICC, Feb. 15, 1978
(19 typewritten pages)
Feb., 1978 Submitted to *Journal of the American Statistical Association*
1/16/79 Accepted for publication with minor changes.
2/15/79 Revision submitted (32 typewritten pages)
2/28/79 Paper returned by Editor for further minor changes.
3/6/79 Revision submitted. To be scheduled for publication in Sept. 79 issue.

"The Occurrence of Fingerprint Characteristics as a Two-Dimensional Poisson Process,"
Tech. Rpt., AFOSR Grant 77-3454, May 15, 1978 (10 typewritten pages)
May,1978 Submitted to *Communications in Statistics*
Dec.,1978 Received Editor's report containing referees' suggestions for revisions.
3/1/79 Sent revision to Editor.

"Testing the Hypothesis of Multivariate Normality against Infinitely Divisible Alternatives," Tech. Rpt. AFOSR Grant 77-3454, Math. Dept., UICC, Aug., 1978 (5 typewritten pages)

8/7/78 Submitted to *J. Multivariate Analysis* (have not yet heard from Editor)
3/3/79 Sent abstract of paper to IMS Annual Meeting Program Chairman

"On the Spectral Analysis of Infinitely Divisible Stochastic Processes," Tech. Rpt., AFOSR Grant 77-3454, Math Dept. UICC, Sept. 15, 1978 (10 typewritten pages)

Sept., 1978 Submitted to *Annals of Probability*
Jan., 1979 Rejected by this journal
(to be revised and re-submitted to *Ann. Prob.* or *Stoch. Proc. & Appl.*)

"Interim Scientific Report," Oct., 1978 (Interim report filed because another proposal was pending.)

"Final Financial Report," Feb. 8, 1979